

# CLAIMS

## **What is claimed is:**

### **1. A method, comprising:**

receiving an optical signal in an optical filter; and

routing the optical signal through the optical filter multiple times, wherein a signal strength of the optical signal reduces with each pass through the optical filter.

2. The method of claim 1, wherein the optical filter comprises two or more reflectors, each reflector having a reflectivity of less than one hundred percent, the two or more reflectors aligned to route the optical signal to circulate between the two or more reflectors.

3. The method of claim 1, wherein the optical filter comprises an acousto-optical tunable bandpass filter.

### **4. An apparatus, comprising:**

an optical waveguide having a core, a cladding, and an interaction region;

two or more reflectors aligned to facilitate multiple passes of a band of wavelengths within an optical signal through the interaction region, the two or more reflectors including a first reflector and a second reflector;

an acoustic wave exciter affixed to the interaction region; and

light-absorbing material interposed between the first reflector and the second reflector.

5. The apparatus of claim 4, wherein the acoustic wave exciter includes an acoustic wave propagation member, a signal generator, and an acoustic wave generator.

6. The apparatus of claim 5, wherein the acoustic wave propagation member comprises an acoustic horn.

7. The apparatus of claim 5, wherein the acoustic wave generator comprises a transducer.

8. The apparatus of claim 4, wherein the first reflector comprises a Fiber Bragg Grating with a reflectivity of less than one hundred percent.

9. The apparatus of claim 4, wherein the first reflector comprises a mirror with a reflectivity of less than one hundred percent.

10. The apparatus of claim 4, wherein the first reflector comprises a recirculator with a reflectivity of less than one hundred percent.

11. The apparatus of claim 4, wherein the first reflector comprises a coupler with a reflectivity of less than one hundred percent.

12. The apparatus of claim 4, wherein the two or more reflectors are aligned to reflect the optical signal bi-directionally through the interaction region.

13. The apparatus of claim 4, wherein the interaction region has a first portion and a second portion, the length of the first portion is based upon an optical wavelength in the optical signal, frequency of the acoustic wave, and type of the fiber.

14. The apparatus of claim 4, wherein the optical wave-guide comprises a single mode optical fiber.

15. The apparatus of claim 4, wherein the apparatus comprises an acoustical-optical tunable bandpass filter.

16. The apparatus of claim 15, wherein a transmission spectrum of the acoustical-optical tunable bandpass filter is less than 18 Gigahertz.

17. The apparatus of claim 4, wherein the acoustic wave exciter is tunable to select a center optical wavelength in the optical signal.

18. The apparatus of claim 4, wherein the two or more reflectors further include a third reflector and a fourth reflector aligned to facilitate multiple passes of the optical signal through the interaction region in a unidirectional manner.

19. The apparatus of claim 8, further comprising:

an acoustic wave absorber affixed to the interaction region.

20. The apparatus of claim 4, wherein the light absorbing material includes a fiber Bragg grating aligned to reflect selected wavelengths at an angle out of the optical waveguide.

21. A method, comprising:

receiving an optical signal;

transmitting an acoustic wave at a first frequency that corresponds to a first optical wavelength; the acoustic wave to cause a band of wavelengths within the optical signal to couple from a first mode to a second mode in an optical waveguide;

absorbing the energy of the optical signal in the first mode;

exposing the band of wavelengths in the second mode to the acoustic wave to cause the optical signal to couple from the second mode to the first mode; and

routing the band of wavelengths through the acoustic wave multiple times.

22. The method of claim 21, wherein the first optical wavelength is proportional to a second frequency applied by a signal generator to an acoustic wave generator.

23. The method of claim 21, wherein a percentage of the first optical wavelength coupled from the first mode to the second mode corresponds to a signal strength of the acoustic wave at the first frequency.

24. The method of claim 21, wherein the first mode comprises a core mode.
25. The method of claim 21, wherein the first mode comprises a cladding mode.
26. The method of claim 21, wherein the first mode comprises a polarization mode.
27. The method of claim 21, wherein coupling comprises transitioning energy from a first spatial propagation mode to a second spatial propagation mode.
28. The method of claim 21, wherein multiple times comprises three or more passes.
29. An optical monitoring device, comprising:
  - an optical signal input;
  - an acoustic wave exciter;
  - an optical waveguide having a core, a cladding, and an interaction region;
  - two or more reflectors aligned to facilitate multiple passes of a band of wavelengths within an optical signal through the interaction region, the two or more reflectors including a first reflector and a second reflector; and
  - light-absorbing material interposed between the first reflector and the second reflector.
30. The apparatus of claim 29, wherein the optical monitoring device comprises an optical power monitor.

31. The apparatus of claim 29, wherein the optical monitoring device comprises a spectral analyzer.

32. The apparatus of claim 29, wherein the optical waveguide further comprises a jacket surrounding the core and the cladding and the interaction region comprises a section of the optical waveguide where the jacket is removed.

33. A method, comprising:

receiving an optical signal in an optical waveguide; and  
generating a set of acoustic waves at N number of frequencies which corresponds to N number of optical wavelengths; each acoustic wave in the set of acoustic waves having an amplitude that correlates to a reduction of optical power in the N number of optical wavelengths, the set of acoustic waves to cause a band of wavelengths within the optical signal to couple from a first mode to a second mode.

34. The method of claim 33, further comprising:

shaping a transmission spectrum by applying the set of acoustic waves to the optical waveguide.

35. The method of claim 34, further comprising:

synchronizing transmitting the set of waves to shape the transmission spectrum.

36. An apparatus, comprising:

an optical waveguide having a core, a cladding, and a first interaction region to allow coupling between optical modes in the optical waveguide; and

an acoustic wave exciter affixed to the first interaction region; the acoustic wave exciter to generate multiple band rejection responses that sweep a band pass of wavelengths across a wavelength spectrum to create a transmission spectrum.

37. The apparatus of claim 36, wherein the acoustic wave exciter comprises one or more acoustic wave exciters cascaded in series along the optical waveguide.

38. The apparatus of claim 37, wherein at least one of the one or more acoustic wave exciters is affixed to a second interaction region.

39. The apparatus of claim 36, wherein the apparatus comprises a band pass filter having a polarization dependence of less than two tenths of a decibel.

40. The apparatus of claim 36, further comprising:

a control component to synchronize the generation of the multiple band rejection responses to shape the transmission spectrum.

41. An apparatus, comprising:

means for receiving an optical signal in an optical filter; and

means for routing the optical signal through the optical filter multiple times,  
wherein a signal strength of the optical signal reduces with each pass through the optical filter.

42. The apparatus of claim 41, wherein the optical filter comprises an acousto-optical tunable bandpass filter.

43. An apparatus, comprising:

means for receiving an optical signal;

means for transmitting an acoustic wave at a first frequency that corresponds to a first optical wavelength; the acoustic wave to cause the optical signal to couple from a first mode to a second mode in an optical waveguide;

means for absorbing the energy of the optical signal in the first mode;

means for exposing the optical signal to the acoustic wave to cause the optical signal to couple from the second mode to the first mode; and

means for routing the optical signal through the acoustic wave multiple times.

44. The apparatus of claim 43, wherein the first mode comprises a core mode.

45. An apparatus, comprising:

means for receiving an optical signal in an optical waveguide; and

means for generating a set of acoustic waves at N number of frequencies which corresponds to N number of optical wavelengths; each acoustic wave in the set of



acoustic waves having an amplitude that correlates to a reduction of optical power in the N number of optical wavelengths, the set of acoustic waves to cause the optical signal to couple from a first mode to a second mode.

46. The apparatus of claim 45, further comprising:

means for shaping a transmission spectrum by applying the set of acoustic waves to the optical waveguide.

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